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Economic Impacts of Modularization Of Dry Grocery Packaging

by

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As marketing activities have expanded in economic importance, greater attention has been focused on the performance of this sector. Studies have found that there are reasons to be concerned about the performance of the marketing system in general and food distribution activities in particular. Productivity and resource utilization have been two of the performance dimensions of concern.

Greater awareness of the performance concerns mentioned above by private and public decision makers has led to a search for ways to improve the functioning of the food distribution system. The standardization of shipping containers (secondary packaging) to form a modular packaging system has been identified as an innovation with a potential for significantly enhancing productivity and reducing food distribution costs. Despite the substantial benefits expected from modular packaging, it has not been adopted for dry grocery products in the United States.

Shipping Container Size Proliferation

Food manufacturers' decisions about retail package shape and size have an impact upon receivers' (wholesale and retail chain distributors) physical distribution operations and ultimately affect consumer food prices. Suppliers design packages to meet the needs of their individual product. A food item's inherent shape and density, its end use, and the portion desired by certain consumer segments determines the item's retail package size. Packages are designed for marketing reasons. The physical dimensions of the package are important product attributes which can be varied to differentiate products. In addition to influencing a consumer's image of a product, package dimensions affect the amount of exposure a product receives on a supermarket shelf.

The diversity in shipping container size is not of critical importance for supplier distribution activities. Suppliers tend to handle in their warehouses and ship large quantities of relatively few items. The impact of shipping container size diversity is markedly different for food distributors. Since distributors ship orders to retail outlets consisting of relatively small quantities of thousands of different items, the basic unit of handling is the shipping container [5]. The full impact of independent supplier package design decisions becomes apparent when the products are intermixed. Each supplier has designed its shipping container without consideration of

how it relates to those of other suppliers. The resulting profusion of container sizes prevents distributors from effectively combining different products, thereby causing inefficiency and waste.

A Modular System of Food Packaging

A proposal to alleviate the problems cited above is to standardize shipping container dimensions into a "modular" packaging system. Sizes of modular shipping containers are a direct multiple of one another and the unit-load size in order to permit maximum flexibility in building mixed product loads [3].

Modular packaging systems have been developed in Switzerland, Sweden and, most recently, in the Netherlands [7]. However, very little progress has been made toward modularization in the U.S. dry grocery industry. In the early 1970s, the topic generated a great deal of interest that culminated in a retail chain trade association sponsored study completed in 1974. This study identified and documented significant savings in distributors' warehousing and transport operations. It proposed further analysis, selection of specific modular sizes and the development of an implementation plan. However, the program was not undertaken by the industry.

The Probable Effects of Modularizing Dry Grocery Shipping Containers

The term "probable" indicates that there is some uncertainty about the effects of modularization. Two reasons for this uncertainty exist. First, the vast, diverse and complex nature of the dry grocery manufacturing and distribution system make it difficult to predict precisely impacts. Assessing the effect of a major system-wide change upon the system is even more difficult. To reduce the magnitude of this task, emphasis will be placed upon identifying immediate impacts upon manufacturers, distributors, and consumers.

A second reason for the uncertainty surrounding the impacts of modularization concerns the modular concept itself. Modular packaging is presently a hypothetical concept being considered for application in the U.S. food industry. While actual modular systems have been developed in several Western European countries, the modular concept has not been put into operation in a specific system in the United States. Until specific modular sizes and the number of sizes to be used are chosen, the full ramifications of implementing modular packaging cannot be precisely known. Because of this difficulty, the direction of the effects of modularization will be described, rather than the precise magnitude of these effects.

Both secondary and primary data are used to predict the consequences of implementing modular shipping containers. Relatively little prior research has been conducted on the effects of modularization. The qualitative and quantitative evidence uncovered through an extensive literature search is utilized to assess modularization impacts. The limited prior quantitative work has focused upon the warehousing and transportation functions of distributors. Primary data used in assessing impacts were obtained via personal interviews with managers in manufacturing and distributing firms, and representatives of trade associations, materials handling equipment suppliers, and academic institutions.

Effects Upon Food Manufacturers

Conversion Costs. The food manufacturing industry would bear the cost of implementing modular shipping containers. Such costs include any adjustment, retooling or replacement of production, packaging, and materials handling equipment necessitated by a modularization program. In a search of the literature, no published studies which assessed the magnitude of these effects were found.

While information about conversion costs for manufacturers is not available, several factors affecting the magnitude of these costs have been identified. First, changeover costs are a function of the degree to which retail (primary) packaging requires modification. Costs are thus directly related to the number of products which can be put into modularized secondary containers without adjusting primary containers [1]. One reason for this is that primary package equipment is relatively less

flexible than secondary packaging equipment. Second, costs are likely to decrease as the time period allowed for implementation increases and as conversion to modular sizes are made in conjunction with equipment changes for other reasons (e.g., metrication, new product introduction and equipment retirement) [1, 6].

Third, manufacturers' costs would be related to the degree to which they will need to redesign their unit loads to fit more precisely on the standard 48 x 40 inch grocery pallet. Currently, many manufacturers design their unit load to extend over the pallet base by as much as 8 inches. Pallet overhang benefits these manufacturers by increasing space utilization on transport vehicles and, in some cases, by reducing damage. Implementing modular packaging would require that unit loads fit more precisely on pallets and thus would increase costs for manufacturers presently benefitting from pallet overhang. Fourth, the degree to which different retail package dimensions would be affected will influence the level of cost. For example, changing can diameters is likely to be several times more costly than altering the height of these packages [1].

Benefits. Evidence on possible beneficial effects of modularization for food manufacturers conflicts. A. D. Little excluded manufacturers' distribution centers from its analysis since researchers believed modularization would have little, if any, impact on these warehouse operations. However, the A. D. Little study did investigate potential benefits of improved space utilization in manufacturers' transport vehicles. They concluded that this opportunity was insignificant since "each unit load is usually made up of only one size secondary carton and there is very little void space in the unit load [1].

Surveys of representatives of manufacturing firms have suggested that, contrary to the above conclusion, some of the benefits of modularization would accrue to the manufacturing sector. In 1978, the General Accounting Office surveyed manufacturing firms in an investigation of container modularization. Eleven of the 19 respondents perceived no benefits or insignificant benefits of modularization for manufacturing firms. Eight respondents indicated that their firms would receive some benefits but the bulk of the savings would accrue to distributors. The most frequently identified areas of savings to manufacturers were: 1) increased space utilization in warehouses; 2) improved shipping and receiving productivity; and 3) reduced packaging inventories. Several firms indicated they would benefit from reduced investment in package machinery. Also, improved productivity from fewer packaging line changeovers and resulting longer production runs were identified as a potential area of savings [10].

A study conducted in 1978 for the National Center for Productivity and the Quality of Working Life surveyed 144 food industry executives regarding the potential for productivity improvement and the legality of ten cooperative behaviors. The 84 manufacturer respondents in the sample (and the remaining distributor respondents) perceived "cooperation among competitors to standardize package size to improve handling productivity" as having the greatest potential to improve productivity of ten joint industry endeavors [4].

Primary data collected through interviews with 18 manufacturing firms provided information about the potential impacts of modularization upon manufacturers. Fifteen distribution executives were queried about the probable effects of modularization upon their firms. The most common response concerned the cost of retooling equipment to make new sizes. Interviewees also identified possible savings through the internal standardization that would result from a modularization program. The major categories of savings and the frequency with which they were identified are shown in Table 1. Savings in distribution operations were often cited as specific benefit areas. A greater ability to intermix different products within a unit load was cited by several respondents. Such preassembled unit loads are often sent directly to stores and can be used as displays. As Table 1 indicates, possible savings in production, storage and procurement were predicted.

Table 1

Areas of Savings From Shipping Container Standardization in Manufacturing Firms Identified By Supplier Distribution Managers

	Number of firms Identifying*
A. Distribution Operations	10
1. Warehouse and/or Transport Space Utilization (8)	
2. Damage Reduction (6)	
3. Productivity in Material Handling (4)	
4. Greater Ability to Mix Different Products of a Manufacturer's Product Line (4)	
B. Production and Packaging Operations	8
C. Storage and Inventory Costs	4
D. Procurement of Packaging	3
E. Other	1
1. Productivity in Handling Inputs (1)	

* Fifteen firms were questioned regarding manufacturing impacts. The total exceeds 15 since most firms identified savings in more than one area.

Some additional evidence that standardization of package sizes would result in savings to manufacturers was uncovered through the interviews. One firm in the sample had undertaken a program in which it reduced the number of retail and shipping packages for a major category of products it produced. Significant potential savings were estimated in: 1) plant operations through reduced packaging line changeovers and improved line productivity; 2) savings in areas of reduced package material inventories and improved utilization of package materials; 3) warehousing savings from reduced inventories and improved space use; 4) transportation savings from increased loading/unloading productivity and improved utilization of vehicles and 5) reduced damage. As a result of the study, the standardization program was undertaken and many of these savings were realized. However, the respondent indicated that while hard dollars and cents savings accrued to the firm, marketing and sales factors created difficulties in implementing the program. Thus, while this program produced hard savings for the firm, the net effect on its market position may not have been positive.

Marketing Effects. A modularization program which limits the shapes and sizes of retail packaging could affect manufacturers' marketing efforts. First, a change in retail packaging could alter a product's image (i.e., price-value relationship) or affect the amount of supermarket shelf space and consumer exposure it receives. Some manufacturers' products may be adversely affected and these firms will suffer a decline in sales. Other firms will be beneficially affected and enjoy sales increases. Thus, as long as the total amount of shelf space devoted to grocery products remains the same, the shifts in sales among manufacturers should cancel one another out and there should be no net impact on the manufacturing sector.

Second, limitations on retail packaging may reduce manufacturers' ability to compete by varying package dimensions to differentiate their products from one another [1]. Greater similarity in retail packages could conceivably allow consumers to compare products on more of a price basis [3]. If competition among food manufacturers shifts from non-price to price attributes, prices will be driven down and manufacturers' profits may decline. Consumers, however, would benefit from lower prices.

A third way in which limiting retail packaging may affect manufacturers is by reducing their options to change packaging as an alternative to changing prices. Package

size and contents are marketing variables. Limits on retail packaging resulting from modularization would reduce this marketing flexibility. This would tend to result in greater competition on the basis of price, since cost increases would be reflected in higher retail prices [3]. Again, while such effects are detrimental to manufacturers, the resulting lower prices would benefit consumers.

Impact Upon Particular Segments of the Manufacturing Sector. Implementing modular packaging could impose relatively higher costs on some sectors than others. Smaller manufacturers may be adversely affected for several reasons. First, smaller firms have less capacity to withstand conversion costs [10]. These firms generally have less market power and thus have less ability to pass conversion costs forward. Second, elimination of odd-sized packages and case packs, which are frequently produced by small manufacturers, would force these firms to compete with larger manufacturers. The long-run result may be that higher cost small manufacturers will fold, reducing firm numbers and competition in food manufacturing [3].

Modularization could impose greater costs on several specific manufacturing segments. Manufacturers of light products (e.g., paper products and cereals) which tend to overhang pallets would incur greater costs in conforming to the 48 x 40 inch pallet than other firms. Also manufacturers using bags for packaging would incur relatively higher costs if they were required to change to corrugated shipping containers.

Effects Upon Food Distributors

Conversion Costs. The implementation of modular packaging should not involve any direct costs to distributors provided that the unit load (i.e., pallet) base remains at the standard 48 x 40 inches. If it were changed, distributors would face major costs in modifying their warehouse racking and layout. However, this is an unlikely prospect given the efforts, which have extended over several decades, to standardize the pallet to this size.

Benefits to Distributors. The types and magnitude of benefits to distributors is probably much greater than those accruing to manufacturers since the full advantage of modular containers, which can be intermixed to create stable unit loads, is realized in distributor operations. Potential benefits that have been identified through surveys and documented through quantitative studies are reviewed below.

For food distributors, the benefits that have been most frequently identified are: 1) increased labor productivity; 2) reduced product damage; 3) improved use of space in trailers delivering store orders; and 4) greater warehouse mechanization and automation. Nineteen of twenty representatives of distribution firms interviewed by the General Accounting Office in 1978 most frequently cited improvement in warehouse labor productivity and damage reduction as potential modularization savings. Benefits from increased automation potential and improved space use in warehousing and transport were each identified by 60 percent of respondents. Distributors suggested possible additional savings through improved inventory control, retail space use, and the use of pre-priced modules for retail display.

The primary data acquired in this research identified many of these same benefits identified in other studies, as well as several new savings areas. In Table 2, the results of interviews with 37 distributor firms are presented. The most frequently mentioned benefit was that of increased warehouse labor productivity. An executive for a national food distributor estimated that modularization would reduce his firm's labor requirements by about 2 percent. This would amount to annual savings of slightly more than one million dollars for the firm. As illustrated in Table 2, savings in trucking, damage reduction and through increased potential for automation and mechanization were identified by many respondents. Nine firms predicted productivity savings at the retail level, while two firms believed manufacturers would benefit from modularization.

Table 2

Areas of Savings Identified by Distribution Managers in Wholesale and Retail Firms

		Number of Firms Identifying*
1.	Warehouse Labor Productivity	25
2.	Improved Utilization of Truck Space	23
3.	Reduced Damage in Ware-Housing and Transportation	22
4.	Increased Automation/ Mechanization Potential	18
5.	Retail Store Level	9
6.	Improved Utilization of Warehouse Space	8
7.	Reduction in Tape/Stretch Wrap for Unitizing Outbound Loads	7
8.	Reduced Training Time for Order Selectors	3
9.	Manufacturing Level	2

* Thirty-seven firms were interviewed. The total exceeds 37, since most firms identified more than one savings area.

The effects of modularization upon distributors have been quantitatively estimated by: 1) A. D. Little, Inc. for the National Association of Food Chains in 1974; and 2) the A. T. Kearney Management Consultants in a joint industry trade association study of shipping container design initiated in March, 1984. The A. D. Little study evaluated impacts upon the wholesale/retail chain distribution center and inbound and outbound transportation. The study found several opportunities for improvement that they were unable to quantify. They were: 1) faster training of warehouse workers; 2) increased flexibility of storage space and of automated systems; and 3) direct warehouse to store shelf-stocking and display on pallets. Savings were quantified in the three major areas of warehouse labor, damage and transportation.

The dollar savings in each of the three mentioned above were estimated for several different warehouse types. In Table 3, A. D. Little's estimates (updated to 1983 dollar values) are presented. The greatest saving potential was found for mechanized systems; the second greatest potential was for conventional warehouses using pallets.

The figures in Table 3 can be used to calculate the total benefits of modularization to supermarket distributors. This calculation requires estimates of the annual dry grocery case flow and current warehouse mix. The estimate of 4.52 billion cases was based on available trade literature. This is probably a conservative figure, since other research has estimated the total number of dry grocery cases at 12.9 billion per year [2]. An estimate of the number of cases flowing through three major warehouse types was derived by consulting with the leading materials handling suppliers to the food industry. Table 4 illustrates the range of potential savings for each warehouse type and the savings on an industry-wide basis. Given existing technology and warehouse types, modularization savings to supermarket distributors would range from 106 to 248 million dollars annually. Two limitations of this aggregate savings estimate should be noted: It is based on figures for typical firms, but it does not necessarily reflect industry averages; and it does not include effects upon small, yet important, segments of the distribution industry [1].

A. T. Kearney, in a joint industry-sponsored study of opportunities to improve shipping container design, has estimated savings from container standardization. Through an industry-wide mail survey of manufacturers

Table 3

Summary of Potential Modularization Savings by Warehouse Type

	($ Per 100 Cases Shipped)			
	Manual (Pallets)	Manual (Tow Trucks)	Mechanized (Pallets)	Automated (Carts)
1. Warehouse Labor*	1.99 + .82	.44 + .20	2.98 + 1.35	.08 + .08
2. Warehouse Damage*	1.26 + .04	.26 + .04	.26 + .04	.26 + .04
3. Transport to Store**	1.11 + .49	0	1.11 + .49	.86 + .37
4. Store Delivery Damage	.50 + .18	0	.50 + .18	.06 + .06
TOTAL	3.86 + 1.54	.70 + .24	4.85 + 2.06	1.26 + .55

* Figures converted to 1983 dollar values using an index calculated from wages for workers in the wholesale grocery trade in *Employment and Earnings*, published by the U.S. Department of Labor, Bureau of Labor Statistics.

** Figures converted to 1983 dollar values using the Producer Price Index for refined petroleum in *Producer Prices and Price Indexes*, published by the U.S. Department of Labor, Bureau of Labor Statistics.

Source for Table: A. D. Little, Inc., *An Examination of the Effect of Modularization of Secondary Containers on Productivity in Grocery Distribution*, Report to the National Association of Food Chains, 1974.

Table 4

Estimated Total Savings Potential of Modularization
Per Year With Existing Warehouse Types and Technology

	Warehouse Types			
	Manual	Mechanized	Automated	Total
Estimated Annual Case Flow (Millions)	4,033.564	410.80[2]	75.636[2]	4,520.000[1]
Percent	89.24%	9.09%	1.67%	100%
Savings Per Year (Millions)				
Lower Bound	93.6	11.5	.5	105.6
Mean	155.7	19.9	1.0	176.6
Upper Bound	217.8	28.4	1.4	247.9

[1]Calculated by dividing 68,804.3 million dollars in wholesale dry grocery sales in 1984 by an average wholesale case value of 15 dollars. The wholesale sales figures were estimated by accounting for 21.9% and 19.4% markup on total retail sales of 60,901.5 and 25,103.8 million dollars for food and non-food grocery sales, respectively (*Progressive Grocer*, p. 42, July 1984) [9].

[2]Estimates calculated from data obtained through personal communication with several major materials handling equipment suppliers to the food industry.

and distributors, and a limited number of interviews with distributors, Kearney researchers identified 29 different shipping container improvements. These improvements were evaluated for their effect upon labor productivity, space utilization and damage in distributors' warehouse operations. A rough estimate of the savings of 21 shipping container improvements was arrived at by calculating the impact upon the largest and most obvious of these three areas. Reducing the number of sizes to form a standardized container system was found to have the greatest savings potential ($116 million per year) of all 29 improvements. Improving bag strength was second in terms of savings ($64 million per year), and three other container size standardization options were among the top five savings opportunities.

A. T. Kearney categorized container standardization and two "partial" standardization measures (i.e., standard pallet height and standard container height) as opportunities for improvement having the "best long-term potential." Two other opportunities (i.e., improving bag strength and standardizing containers with similar retail packages), which offered significant savings yet affected fewer cases, were deemed to be a "good place to start" improving shipping containers. Therefore, these two improvements were recommended for further study [2].

A. T. Kearney's calculations of the potential savings of container standardization can be regarded as a conservative estimate for three reasons: First, it would have a potential impact on three areas, and only one of these areas was quantified to arrive at a "rough order of magnitude" savings figure for each improvement. To the extent that a shipping container improvement has significant benefits in the areas that are not included in the calculation, this method will understate its potential savings. Thus, the potential savings of container standardization, which has benefits in several areas of distributors' warehouse operations, is likely to be greater than $116 million per year. Second, potential warehouse savings from the increased automation and mechanization made possible by container standardization are not included. Finally, benefits in transportation, which have been found to be significant in other studies, and the effects at the retail store level were not evaluated.

Potential Consumer Impact

Consumers may be affected by modularization in two ways. They will be affected by any modifications in retail packaging. Also, modularization could affect consumers through the prices they pay for food.

Legitimate reasons for differences in retail package sizes are to meet consumer preferences for different quantities of a given product, to provide convenience in use, or to create aesthetic appeal. If a container modularization program limits retail package sizes, some retail packages will require modification. The resulting retail packages may be more preferred or less preferred by consumers. If modularization results in retail packages which contain product portions or attributes that are less preferred by some consumers than former sizes, these consumers will be inconvenienced. Thus, it is possible that a modular container system which severely limited retail packaging could make the food marketing system less responsive to consumer preferences.

To the extent that implementations require major changes in their operations, manufacturers' costs will initially be raised. In this largely oligopolistic industry, most firms should be able to pass on these increased costs to distributors. There are three possible results for consumers; these results will depend on the degree of competition at the distributor level. First, if distributors possess substantial market power, and can therefore retain modularization savings accruing in their operations and pass manufacturers' product price increases forward, consumer prices will increase. Second, if distributors pass on only enough of their savings to offset the increases in manufacturers' prices, consumer prices will be unchanged. Third, in a competitive environment, market forces will, over the long term, compel distributors to pass on all or most of their savings, thereby reducing food prices to the consumer.

The most likely outcome for a modular package system with demonstrated net benefits is a reduction in consumer prices, although prices will probably not be reduced by the full amount of the savings accruing to distributors. Manufacturers, who must incur costs to modularize their products, can benefit from expanded sales only if distributors reduce product prices. Therefore, manufacturers would probably only cooperate in a modularization program if enough of the savings accruing to distributors were passed on to offset increased manufacturers' prices. If this occurred, all three parties could benefit from modularization. Consumers would benefit through lower prices. Increased purchases induced by lower prices would increase the volume of manufacturers' sales and, possibly, their revenues and profits. Profits for distributors with sufficient market power to retain at least some of the savings of modularization would be raised. Even in the case where increased profits due to modularization savings are eroded through competition, the result would be a normal return on investment for these firms.

Conclusion: Evidence of Net Benefits

For an innovation to be worth undertaking, it must pass the benefit-cost test. In the case of modular packaging, the benefits must be greater than the conversion costs if total marketing system costs are to be reduced and consumer prices lowered. Only a part of the information (i.e. benefits to distributors) that is needed to make a net benefit comparison has been quantified. No quantitative estimates of the costs and potential benefits for manufacturers are available.

Several investigators have concluded that modularization would produce net system savings. For example, the General Accounting Office concluded that the "result is likely to be that the food system as a whole will benefit but not all segments" [10]. Furthermore, researchers investigating dry grocery losses indicated that the task of modularizing packaging would be arduous, but the results would appear "certain to be worth the effort" [8].

A review of the primary and secondary data acquired in this research leads to the conclusion that one or more modular packaging systems would produce significant net benefits and thereby lower total food distribution system costs. This conclusion is based on four points. First, a modular container system would have reasonably low conversion costs if it had a sufficient number of sizes so as not to require substantial retail package change; and if there were a reasonable implementation period, so that manufacturers' operations would not be quickly disrupted, and changes could coincide with the normal cycle of package change. Second, despite the fact that modularization has been a food industry issue for over fifteen years, this research uncovered no quantitative evidence demonstrating that conversion costs would be large. Third, some manufacturers would receive benefits from modularization which would at least partially offset conversion costs. Finally, the quantitative estimates of distributor benefits are conservative since a conservative dry grocery case flow figure was used and the benefits in retailing and from technologies stemming from modularization have not yet been estimated.

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